

WHAT IS CLAIMED IS:

1. A vibration wave driving apparatus
comprising:

5 a vibration member having a shape line
symmetrical with respect to two orthogonal planes;
electro-mechanical energy conversion elements
which can excite three different types of bending
vibrations, in said vibration member, which displace
in a direction of axis common to the two planes; and
10 a driven member which is brought into contact
with driving portions of said vibration member and
driven by vibrations excited in said vibration member.

2. An apparatus according to claim 1, wherein
15 said electro-mechanical energy conversion elements
which can excite the three types of bending
vibrations are arranged in the same plane.

3. An apparatus according to claim 1, wherein
20 said vibration wave driving apparatus drives said
driven member in an arbitrary direction in three
dimensions by selecting and exciting two of the three
types of bending vibrations.

25 4. An apparatus according to claim 1, wherein
the driving portions of said vibration member
protrude from said vibration member in a direction in

which the three types of bending vibrations displace.

5. An apparatus according to claim 1, wherein two of the three types of bending vibrations have the same vibration pattern and are 90° out of phase from each other in the same plane.

6. An apparatus according to claim 5, wherein one of the two types of bending vibrations has a node at which an antinode of the other bending vibration is located.

7. An apparatus according to claim 1, wherein the three types of bending vibrations have the same natural vibration frequency.

8. An apparatus according to claim 1, wherein said driven member has a curved surface that comes into contact with the driving portions of said vibration member.

9. A vibration wave driving apparatus comprising:

a vibration member which is made up of a plate member and projections protruding from a surface of the plate member and has a shape line symmetrical with respect to two orthogonal planes;

electro-mechanical energy conversion elements
which are fixed to the plate member and excite three
different types of bending vibrations that displace
in a direction perpendicular to the plate member; and

5 a driven member which comes into contact with
the projections of said vibration member,

wherein two of the three different types of
bending vibrations are selected and synthesized to
drive said vibration member in an arbitrary direction
10 in three dimensions.

10. An apparatus according to claim 9, wherein
said electro-mechanical energy conversion elements
are arranged in the same plane.

15

11. An apparatus according to claim 9, wherein
two of the three types of bending vibrations have the
same vibration pattern and are 90° out of phase from
each other in the same plane.

20

12. An apparatus according to claim 11, wherein
one of the two types of bending vibrations has a node
at which an antinode of the other bending vibration
is located.

25

13. An apparatus according to claim 11, wherein
the two types of bending vibrations differ in

vibration pattern from the remaining type of bending vibrations.

14. An apparatus according to claim 11, wherein
5 the two types of bending vibrations are excited by said same electro-mechanical energy conversion elements.

15. An apparatus according to claim 9, wherein
10 the three types of bending vibrations have the same natural vibration frequency.

16. An apparatus according to claim 15, wherein
15 a mass of said vibration member is increased at a position corresponding to an antinode of one of the three different types of bending vibrations which has a short wavelength.

17. An apparatus according to claim 9, wherein
20 said driven member has a curved surface that comes into contact with the driving portions of said vibration member.

18. An apparatus according to claim 9, wherein
25 said vibration member has a square outer shape.

19. An apparatus according to claim 18, wherein

the projections are arranged at substantially middle portions on the respective sides of the square.

20. An apparatus according to claim 18, wherein
5 the projections are arranged at corner portions of the square.

2025 RELEASE UNDER E.O. 14176